

IBS Scientific

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The Evolution of a Bridge to Religion

Where Do Religion and Evolution Meet?

Also Inside

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- The Insights of DNA Computing
- The Trip of Cancer From Genetics to Mathematics



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A Welcome Note

Dear reader,

It is with great pleasure that we present to you the inaugural issue of Ibn Badis Scietific which is an open access peer reviewed magazine. It is the result of collaboration between a group of research students, and was formally launched on the Algerian Day of Science, the 16th of April, which is celebrated in remembrance of the teacher of generations of Algerian scientists and engineers, Abdelhamid Ibn Badis.

It is common wisdom that communication is regarded as the pillar of scientific achievement. One only needs looking at the pinnacle of Islamic science in the first millennium and the achievements of western science in the last century, which were, to a great extent, due to the prosperity of publication at the time.

Nowadays, publishing is acutely very little in the Islamic scientific circles. This magazine is the first step in reviving this activity, and giving opportunity for other scientists, engineers and social researchers to join in this noble work. To achieve this task, we define our aims as follows:

- The publication and discussion of our ideas.
- Linking different disciplines and professions.
- The creation of a medium and a network for collaboration between scientists.
- The establishment of a backbone for Algerian science at home and overseas.

The aims are general and ambitions, but it is our belief that they are not only realistic but achievable in the long run. It is the time to dedicate time and effort to build such an important infrastructure. This is an opportunity that will allow every scientist and engineer to advance their communication skills in English; and we need not stress the place of English in science education worldwide.

The ultimate objective of this magazine is to develop into a fully fletched journal. This will be the link, currently missing, between Islamic and global science which will undoubtedly benefit both.

The first step for you as a student, scientist, engineer, technologist or social scientist is to write us an article explaining a phenomenon, proposing an idea, clarifying a concept, or reviewing literature on a particular field from Anaesthetics to Zoology. There are certainly clear benefits of teaching ourselves scientific writing and reviewing as we all have to do either or both in our careers.

This magazine will be the helping hand for PhD students, the meeting place of postdocs, the fishing pool for group leaders, and the teaching ground for professors. So join us... the journey has just begun...

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The Inspiration Behind...

Sheikh Abdelhamid Ibn Badis



Above:
Sheikh Abdelhamid Ibn Badis,
the leader of the association
of Muslim scholars in Algeria

Abdelhamid Ibn Badis is an Algerian icon. He was an Islamic reformer and scholar, known for his great leadership skills, excellent teaching techniques and wide ranging knowledge and achievements. He is one of the most influential scholars of the last century, and is renowned as one of the first leaders of the reformist movement in the recent past.

Born to a well known Constantine family in 1889, he made his fingerprints in the history of a nation and a religion. He was an Islamic scholar mastering Tafsir and Hadith, a historian, and a great teacher. After finishing his traditional education, he joined the Zitouna University in Tunisia where he was a lecturer. During that time, he tried to diagnose the most important factors influencing social order and identify the needed cures. He noticed that Algerians were plagued by illiteracy and decided that establishing schools with clear and defined objectives was the solution.

In 1913, he visited the holy cites in Mecca to fulfil his pilgrimage duties, and met his future collaborators. He came back home with the intention of establishing schools and publishing newspapers in Arabic, the language of his people. The journey was very torturous and he saw his newspaper seized after 18 issues. However, he never gave up and published few in the period between the two world wars.

He opened few schools in different parts of the country, all of which were very successful. Some of his students were to be presidents and ministers after the independence. Malik Ben Nabi, for example, studied electrical engineer and was very influential in establishing higher education and promoting scientific research in Algeria.

In 1931, Ibn Badis established the Algerian Muslim Scholars Society with the help of his students and peers. At first, it was mainly composed of social scientists but also welcomed new breed of scientists and engineers. The association is still running strong to this day.

Ibn Badis was a man of steel who established a backbone for Algerian intellectualism and made it heard to other parts of the world by using his pen only.

After a long illness, he was announced dead on the 16th of April 1940, which is still celebrated as the day of science in remembrance of his various achievements.

Ibn Badis made whole generations do what peers dreamt of, he taught us our pride, our potential, our ability and our need. We have only to listen, learn and follow in his footsteps.

Elhadj BENKHELIFA & Abdelkader ESSAFI

Science: Cancer Therapeutics

"The best cancer cell is the one that could die" ...Is it all in the Bcl-2 family?

CANCER cells develop means to escape programmed cell death (apoptosis), so they become immortal. Most radiotherapy and chemotherapy regimens aim to target cancer cells selectively and cause them to die. Bcl-2 family of cellular proteins represent a paradigm of anti-apoptotic factors, which when overexpressed in cells contribute to tumour development. Using structural studies Rosenberg and colleagues identifies a small molecule inhibitor of Bcl-2 and Bcl-X_i, which causes the regression of established tumours and improves survival in animal models.

After resolving the structural basis and mode of action of Bcl-2 and Bcl-X_i, Rosenberg and colleagues screened a larger library of small compounds and identified a potential inhibitor. This resulting candidate compound was then chemically modified to increase specificity and efficacy, producing the molecule ABT-737. ABT-737 augments the anti-tumour effect of several existing therapeutics (etoposide, doxorubicin, cisplatin and radiation) in cultured cells and patient-derived primary cells. The drug also caused the regression of tumours (xenografts) growing in mice.

After a long wait, this demonstrates that small molecule inhibitors of Bcl-2 family could be very useful as a single anti-cancer agent against lymphomas, and potentially against other cancers in a combination therapy.

Oltersdorf T, et al. *Nature*. 2005 Jun 2; 435(7042):677-681 (2005)

Science: Biophysics

Dear Sikorsky, we solved it: The hovering hummingbird

THE hummingbirds (Trochilidae) are fascinating birds, with Zidanian talents. Being the smallest bird known, it can fly in all directions, and hover as well. Its heart beat is exceptional, in a dive it reaches at more than 1200 beats per minute, while flapping its wings up to 2000 round per second. In this week's issue of nature, another question is

answered: how can they hover for so long?

It was assumed that the aerodynamics of hovering in these birds resemble those of insects. This was not supported by the musculoskeletal differences. A detailed analysis was needed to explain the mechanism by which these vertebrates hover. Using a sophisticated digital imaging technique, Digital Particle Imaging Velocimetry (DPIV)-DPVI is used to study the flow of liquids and gases-, scientists from Oregon State University, University of Portland and George Fox University, showed that difference in hovering dynamics lies in the difference between the wing's up and down stroke; in their experiment, they allow a bird into a wind tunnel with some droplets of olive oil; capturing the position of these droplets when the bird is hovering, gives direct reflection of the flow of air around its body. Using computer analysis, they found that hummingbirds support 75% of their weight in the downstroke, and 25% during the upstroke, in contrast to other birds that support all of their weight in the downstroke. It also challenges the perceived belief that symmetry in the flap strength, would explain better the ability of these birds to hover for a long time as inferred from data from insects of similar sizes.

These findings are important in explaining the evolution of flight in birds and insects. They can also be used in craft design especially helicopters (it is rumoured that Igor Sikorsky studied the flight of hummingbirds while going through the different design of his famous helicopter).

Warrick DR, et al. *Nature*, 2005 Jun 23;435(7045):1094-7

Science: Parasitology

Your Friend is my enemy... elephantiasis

IN tropical regions a bite by mosquito is almost certainly coupled with an injection of some parasites in the blood stream, threadworms are such parasites. Threadworms (Wuchereria bancrofti) have a life cycle of five years spend in two different hosts: the mosquito and the human body. Once in the human body, they attack first the lymph nodes,

and the body counter attacks by producing inflammation and stopping the lymph circulation flow. This in turn results in swelling of legs, arms and genitals to monstrous proportions, hence the name of the disease: Elephantiasis. Targeting the larvae of these worms (micro-filariae) is now the best therapeutic solution to the disease, most of the harm, however, is done by the adult worms. The twist is that their prolonged life span made invincible, till now. In an article published in the Lancet, a trial with a very modest drug has delivered the goods!

Professor Achim Hörauf and colleagues have at last found a way. The threadworms seem to be dependent on symbiotic bacteria, and by killing the bacteria, the worm will die sooner or later. In their trial, in collaboration with researchers in Tanzania, they treated 72 patients with either an antibiotic (doxycyclin) or a placebo. The results showed almost complete eradication of the worms from the blood stream of doxycyclin treated patients but not with the placebo group. This approach is highly praised and extremely significant. It shows the importance of basic research for delivering simple, effective and low cost drugs. Doxycyclin is already licensed and cheaply available for sub-Saharan Africa. It is also harmless, with few side effects in children.

Taylor MJ, et al. *Lancet*. 2005 Jul 7; 365(9477):2116-21.

Science: Cancer Biology

Always look at the origins...

FROM what cells does cancer arise? is an old question among cancer scientists. For those working on blood cancers the answer was provided recently, and now lung cancer scientist should read more about stem cells. In the 17 June issue of cell, researchers from MIT have provided evidence of the development of lung cancer from stem cells within the bronchialveolar duct junction of mice. They isolated these cells (always a tricky business to do); allowed them to grow, propagate, and differentiate. Most significantly, the stem cells can be activated and transformed by the expression of the K-ras oncogene,

a known cancer inducer.

This work provides a new view to the normal development of the lung tissue and the staging of lung cancer (see Kaidi's article in this issue of *IBScientific*). It also provides a new window of opportunities for therapeutic intervention of this cancer.

Kim CF, et al. *Cell*. 2005 Jun 17;121(6):823-35

Science: Medicine

Hale and healthy

THIS week, scientists from the Institute for OneWorld Health, the first not-for-profit pharmaceutical company in America, presented the results of a large clinical trial at the Third World Congress on Leishmaniasis in Palermo, Italy. Leishmaniasis is a parasitic infection transmitted by the bite of a sand fly. The trial shows that an antibiotic called paromomycin is effective for treating the most dangerous version of the disease, visceral leishmaniasis, which affects 1.5m people around the world and kills 200,000 of them every year. Those data are obviously important for medical reasons. But they are also important as a demonstration that the institute's novel approach to drug development is working.

About 90% of the planet's disease burden falls on the developing world. Yet only 3% of the research and development expenditure of the pharmaceutical industry is directed toward those ailments. The rest goes towards treating diseases of the rich. In 2000, Victoria Hale, founded the institute to help tackle that discrepancy. She knew from her work as a scientist in the pharmaceutical and biotechnology industries, and subsequently as an official at America's Food and Drug Administration, that numerous promising drug-development projects—particularly for diseases of the poor—are dropped for lack of funding. She reasoned that there was a gap in the market, between academically inclined university departments and fully fledged pharmaceutical firms, for an organisation that would identify such orphans, get their owners to donate the intellectual property if they were still in patent, raise development funding from non-commercial sources, and arm-twist researchers to contribute their expertise to the development process *pro bono*.

<http://www.oneworldhealth.org/diseases/leishmaniasis.php>

Science: Immunology

Lifestyle vaccines

SMOKING causes a third of cancer deaths, but quitting brings immediate benefit. In fact, someone who quits before the age of 50 is half likely to die of cancer in the subsequent 15 years as he would be if he kept smoking. The trick, then, is helping people quit. With that goal in mind, Cytos Biotechnology, in Zurich, has, as it announced to the American Society of Clinical Oncology meeting held last week in Florida, made progress in developing a vaccine against nicotine.

The idea of a nicotine vaccine is to stop the drug getting to the brain in the first place. People who are vaccinated should develop antibodies that bind to the nicotine in their bloodstreams, disabling it. If no nicotine reaches the brain, there will be no pleasurable reward for having a cigarette. So vaccinated individuals should—in theory—be less likely to relapse. This approach is not unique to nicotine. Vaccines against cocaine, another addictive recreational drug, are also being developed. But the results announced in Orlando suggest that Cytos's nicotine vaccine is now the closest to being deployed.

http://www.asco.org/ac/1,1003,12-002634-00_18-0034,00.asp

Technology: Computing

Battle of the Coders

LAST-minute programming prowess wins the International Collegiate Programming Contest for a Chinese university.

The competitors unfurl their nation's flag and toss their coach in the air. No, this isn't the Olympics. It's the Association for Computing Machinery (ACM) International Collegiate Programming Contest, held in Shanghai, China, this year on 6 April.

Shanghai Jiao Tong University, in a surprise finish, took first place, having written programs to solve several of the problems in the homestretch of the competition. Up to the last few minutes of the contest, Moscow State University and the St. Petersburg Institute of Fine Mechanics and Optics had been in neck-and-neck competition for first place.

Out of the 4109 teams from 71 countries who competed in regional contests worldwide, 78 made it to the world finals. The finals presented 10 programming problems and gave the teams 5 hours to solve them. Using the operating system Eclipse and programming languages such as Java, C++, and Pascal, the team that solved the most problems in the least number of tries and in the shortest time won the contest. The competition presented problems like devising a program that, say, figures out the cheapest way of renting cars in order to get a group of judges to a contest.

IEEE Spectrum Online

Science: Physics

Honest!

A report of a desktop experiment that produces nuclear fusion is bound to raise eyebrows. But this time, the results look convincing: physicists who meddle with cold fusion, like psychologists who dabble in the paranormal, are likely to be labelled quacks by their peers. This is due to an infamous incident in 1989 when Stanley Pons and Martin Fleischmann held a press conference to announce their discovery of nuclear fusion in what amounted to a test-tube full of water connected to a battery. In particular, they said that they were getting more energy out of the process than they put into it. Their result was instantly dubbed "cold fusion", to contrast it with giant fusion-reactor experiments that attempt to reproduce the ultra-high temperatures found inside the sun. But when it failed to stand up to scrutiny, confusion—and eventually outrage—ensued.

In 2002, history repeated itself as farce with the announcement by a group at Oak Ridge National Laboratory in Tennessee of fusion inside the bubbles that are produced by ultrasonic waves travelling through a liquid. This result passed the peer-review process, but was immediately attacked by another group—from the same laboratory—which claimed to find no such effect. There was a counterclaim by yet a third team last year, and a final verdict on "bubble fusion" is still not in. But most people have lost

interest in the debate, assuming that anyone claiming to have observed fusion in a desktop experiment is a crank or a fraud. This attitude, however, may yet turn out to be mistaken. Desk-top fusion may be possible after all, according to an article published in this week's *Nature* by three researchers at the University of California, Los Angeles (UCLA).

Zwierlein MW, et al. *Nature*, 2005 Jun 23;435(7045):1047-1051

Economics

A new ranking of Muslim firms

WHEN it comes to making money, Muslim countries—particularly those in the Middle East—are best known for oil and gas. But dig a little deeper and you will find a wealth of different businesses. So says Dinar Standard, a new online business publication, which has produced an inaugural ranking of the top 100 domestic firms in the Muslim world—that is, the 57 countries that make up the Organisation of the Islamic Conference (OIC).

The Economist

Science: Physics

Never late again!

Soon, we will have cheap atomic wristwatch that will need 300 years to lose a second. Compared with its quartz counterpart, which loses or gains a second every day.

Researchers at the U.S. National Institute of Standards and Technology (NIST) have invented the smallest atomic clock. Its core is the size of a grain of rice; it uses some of the same principles as the institute's primary clock, which is about the size of a compact car. Both clocks use electromagnetic radiation to cause cesium atoms, in vapour, to oscillate at a stable frequency. In the primary clock, the radiation is a microwave field, while in the chip-scale clock it is pulses of infrared light from a laser. Right now the cesium vapour chamber takes up a few cubic millimetres. Adding the laser, the optics, and the electronics and we are at around a cubic centimetre.

So what? Why can't we just keep

using quartz? And use standard chunky expensive atomic clocks for greater precision tasks. The answer is simple, to an engineer doing the same thing smaller and cheaper is actually something new. Tiny atomic clocks would make a big difference in many applications. For instance, Global Positioning Systems need at least four satellites to place you accurately. However, with perfectly synchronised clocks between you and the satellite only three satellites are needed. There's spread spectrum communication, where the transmitter sends data by hopping around different frequencies. With such a clock, the receiver can lock to a carrier frequency more quickly and precisely, so transmission is faster at a lower error rate. Faster transmission will also make it harder for eavesdroppers to listen in.

Together with NIST, Symmetricom, Honeywell, Rockwell Scientific and Sarnoff Corp. are developing their own chip-scale clock designs.

IEEE Spectrum May 2005

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Science: Biology

Biology Taken Over by Mathematics, a Merger of Titans

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BIOLOGY has advanced at an impressive rate in the last decades, and has done so by standing on the shoulders of giants, but not as much on the giant of them all: Mathematics. As more computers than ever are being used by biologists, we have started to witness some remarkable developments at different levels: genes, proteins, cells, organs, species and societies. Kaidi (Bristol University)¹ has explored in some detail the example of cancer. In so doing, he journeyed through biological findings of cancer scientists over the last few decades and painted a clear picture about tumour development and the different causative players at the molecular level. This was achieved chiefly by biological approaches and methods; successfully treating some cancers such as Chronic Myeloid Leukaemia, and discovering prognostic and diagnostic markers (markers of tumourgenesis)(Griffin, 2001). The way forward, Kaidi suggested, is to resolve to mathematics to give us models for tumour progression based on biological findings. These will be valuable not only for the understanding of the disease but evaluate potential treatments.

In a second article, Mokrab (Cambridge University)² introduces computational biology as a new progeny of biology. He explains how mathematical models and computer simulations are being increasingly used to study and analyse biological systems of varying degrees of complexity. As an example, he describes pioneering work on the modelling of the human heart in an attempt to obtain a deeper understanding of coronary circulation and reconstruct many of the life-threatening human heart conditions. He then went on to discuss the concepts surrounding mathematical biology and the potential rise of a self-established theoretical biology, which will hold rigorously described laws and principles that can underpin biological phenomena at all levels. This may ultimately lead to the deciphering of the meaning of life on Earth.

How can biology advance even further in the 21st century?

The answer provided, according to these two articles is plain and simple: mathematics. However, not all biologists are easily charmed by the magic of mathematics, and still hold biological knowledge as a separate entity from other mathematics based knowledge. The two biologists, however, agree on the importance of the biological significance of data unearthed using mathematics. The two articles put a strong case for their thesis, but there is always another way to interpret the data.

Griffin, J. (2001). The biology of signal transduction inhibition: basic science to novel therapies. *Semin Oncol* 28, 3-8.

¹ Kaidi, A. (2005). Cancer from Genetics... to Mathematics. *IBSscientific*, 1, 16-17.

² Mokrab, Y. (2005). Modelling Life: The Birth of Computational Biology. *IBSscientific*, 1, 18-19.

Science: Biology

Finally...a Bridge*

Abderrahmane KAIDI
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On the cover page of a recent issue of Nature: "This journal contains material on evolution. Evolution by natural selection is just a theory not a fact..."³. Bridging the gap between evolution and religion has proven difficult; in fact traditionally there has been a severe reciprocal rebuff. In this issue of *IBSscientific*, Essafi (Imperial College London) presents a model in which the theory of evolution can co-survive with religion harmonically⁴. The author identifies the heart of the problem as being misconceptions on both camps. For instance, the notion that evolution provides an evidence for the non-existence of God is a no more than a prejudgement imposed by fundamentalist religious views. Using rational and based on the clear aims of evolutionary biology, Essafi convincingly deduced that the reason for such elusions is the mistaken association between evolution and atheism. He also suggests that religious people should try to understand the scientific method and its shortcomings.

The author then puts the theory of evolution in a historical prospective that spans for over a century. This took the theory from a jungle exercise to mathematical modelling making use of the advancement in biology and other disciplines. Referring to the mechanisms of evolution Essafi, introduces the fundamental evolutionary concepts, including natural selection, sexual selection, genetic drift and neutral theory. After a critical assessment and profound examination, these mechanisms altogether fail to truly/fully explain speciation and the arising of complexity, the author adds.

When considering the human knowledge, which encompasses relative and absolute truths, the author points out that the nature of the scientist determines the source of absolute knowledge. For a religious scientist the absolute truth is only communicated from God; for an evolutionist scientist however, the scientific truth is more absolute and trustworthy. The former, by definition as a belief, does not require any proof, however the latter does. Since there is now unambiguous evidence for the theory of evolution it still remains under the shadow of relative truth.

To conclude the author reiterate by regarding science generally and evolution specifically as a possible way to explain phenomena gainfully, interestingly religion (more specifically Islam) also aims to that by promoting acquisition of beneficial knowledge of any sort as well as

enhancement of spirituality and faith. In the case of Islam, verse 5 from Surat El-Fetiha (Chapter 1: The Opening, 5) states “Thee do we worship, and Thine aid we seek”, this inspires Muslims to worship Allah and seek his help not only in worshipping but also in understanding and making use of the universe, in other word science.

³ Nature, 28 April 2005.

⁴ Essafi, A. (2005). The Evolution of a Bridge to Religion. *IBScientific*, 1, 12-15.

*Also reviewed by Dr John Parker, Biological Sciences, University of Bristol.

Technology: Computing

Top Gear!

Younes MOKRAB

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SOFTWARE and hardware engineering has known a remarkable expansion over the last decade. As more giant firms and corporate gain more monopoly through publicity and marketing, there is a need for strategies to independently assess quality and standard for commercial computer products.

In his article⁵, Naci (Cambridge University) presents a nice overview of benchmark tests used to compare performance of hardware and/or software. He first introduces the general concepts underlying many of the benchmark tests used when reviewing a product of interest. He moves on to distinguish between the different types available. Finally, he raises some issues about the interpretation of benchmark results. He puts highlight on the importance of knowing exactly what the benchmarks are designed for, before using them to compare benchmark results.

The high relevance of software/hardware industry to modern society and economy puts enormous pressure on the design and maintaining of efficient methods to keep high levels of performance and quality. Naci has tried to expose the issues surrounding this, probably changing views many of us would have.

⁵ Naci, S. (2005). Who's The Best. *IBScientific*, 1, 10-11.

Technology: Computing

“Can Biomolecules Compute?”

Sofiane NACI

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THE recent advances in computing have lead to a noticeable increase in the use and application of the theory

of Computer Science to solve biological problems. One of the latest shifts in this direction is exploring the potential for computation using information carrying polymers such as DNA.

In this issue of *IBScientific*, Teffahi (Cambridge University) tells the full story. In his article⁶, Teffahi presents a summary of previous work about the possibility of using DNA for computation, and the more recent achievements in this direction. He first gives a throughout explanation of the theory underlying digital computer systems, know as Turing machines. In this introduction, he also summarises the prior art, started in 1994, in using the theory described earlier in DNA computation.

Since then, Turing machines have been used to construct more complex models. Teffahi gives a detailed description of the first one which was presented in 2001. Finally, he concludes by summarising the insights of the possibilities of using DNA in computation.

The useful properties of DNA, such as its massive parallelism and its ability of self-assembly, make DNA computing the ultimate solution to solve hard computational problems such as optimisation. Teffahi has highlighted the research activities in this hot field, and which all compete to discover more useful applications of DNA in computing.

⁶ Teffahi, M.A. (2005). From Turing Machines to DNA Computing. *IBScientific*, 1, 8-9.

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From Turing Machines to DNA computing

Mohamed Ali TEFFAHI

The Computer Laboratory, University of Cambridge
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In 1945, physicist Erwin Schrödinger described the molecular nature of the gene in information-theoretic terms. He asked: "Can biomolecules compute?" In his book *WHAT IS LIFE?* Now, 60 years later, computer scientists, molecular biologists and chemists are joining forces to explore the potential for computation using information-carrying polymers such as nucleic acids (DNA and RNA).

WHEN Alan Turing proposed the finite automata concept – the theory underlying digital computers – in 1936, he left the device's physical nature unspecified. Automata machines are represented by a tape on which symbols are written and erased, systems to read and write symbols, and a set of rules that act on the initial set of input symbols (See Figure [1]). Within decades, electronic devices were used to construct such devices first using vacuum tubes, then transistors. Leonard Adleman demonstrated the possibility of using DNA for computation in 1994 by solving a seven-node graph problem (finding a path that visits each node exactly once) using recombinant DNA technology. In his technique, a sequence of short single-stranded DNA polymers (oligo-nucleotides) encoded the names of nodes, a self assembly technique then generated a library of possible solutions, recombinant DNA techniques selected those sequences that met the problem's requirements and gel electrophoresis – a standard technique for separating macromolecules – served as the means of output. Since his experiment, several other laboratories have produced demonstration systems that use DNA's properties to solve more complicated problems, but to operate; they need full-scale laboratories and human intervention.

Turing Machines are abstract models of computation, defined by Turing to give a mathematically precise definition of algorithm or "mechanical procedure".

A TM can be realized in a form of a mechanical machine that consists of:

1. A tape that is assumed to be divided into cells that contain a symbol from some finite alphabet.
2. A head that can read and write symbols on the tape and (eventually) move one step left or right.
3. A state register (known also as "internal state") that stores the state of the Turing machine.

An action table that tells the machine what symbol to write, how to move the head and what its new state will be

randomly synthesized. In this approach, an enzyme, RNase H, breaks down those RNA chains that did not meet the problem's constraints by attacking the RNA strand of DNA- RNA hybrid molecules.

The Princeton researchers write in their PNAS article, "A value of 0 or 1 is assigned to a specific bit position by destroying all strands in the RNA library which do not have the value at this position." Researchers repeat this process by applying the other constraints, and DNA molecules complementary to the remaining RNA strands were generated using polymerase chain reaction.

The researchers sequenced complementary DNA to the resulting 43 distinct RNA molecules, and read them by sequencing the DNA. Of the 94 possible solutions to a 3x3 Knight problem, the researchers randomly selected 42 proper solutions; one solution, involving an illegal placement of a knight, was incorrect, giving a 97.7 percent success rate in finding correct solution strands.

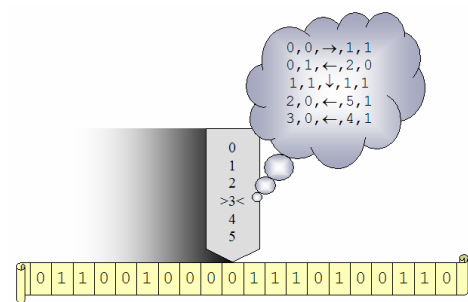
Insights

Originally, the goal of DNA computing, as envisioned by Adleman and others, was to solve numerical problems. "You pose some hard

Below:

Figure 2. Molecular realization of an automaton. An input DNA molecule (green/blue) provides both data and fuel for the computation. Software DNA molecules (red/purple) encode program rules, and the restriction enzyme FokI (coloured ribbons) functions as the automaton's hardware.

A finite-state automaton that analyzes its input (a list of a's and b's) according to program rules depicted as labelled arrows, ends the computation in S0 if the input has an even number of a's and in S1 otherwise. Source: Weizmann Institute of Science.



Above:

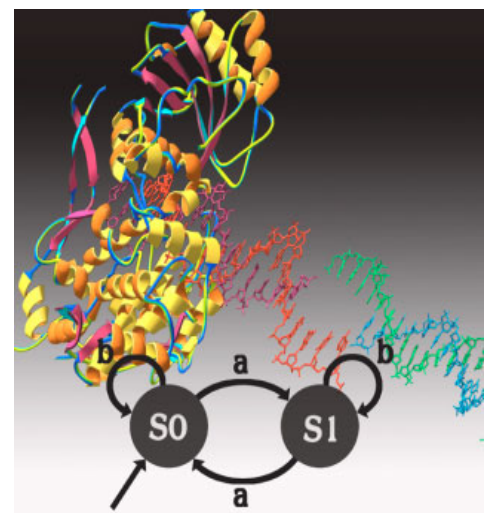
Figure 1: A theoretical model of computation, described by Alan Turing in 1936, now known as a "Turing machine" (TM).

First proposed model

In the November 2001 issue of *Nature*, Ehud Shapiro and his colleagues report the development of a macromolecular version of a two-state finite automaton with an alphabet of two signals ("a" and "b" each represented by a six nucleotide sequences) and a termination sequence. Eight distinct, short, double-stranded DNA molecules represented the eight possible transition rules. These are expressed through specific molecular biological events. Enzymes that recognise and act on specific DNA base sequences – either by cleaving a recognised

sequence to form a four-base-long sticky end (FokI) or by creating a chemical bond (ligation) between fragments of single stranded DNA held adjacent by an overlapping complementary sequence (ligase) – cause transition according to the rules. DNA molecules also represent the automaton initial state and DNA molecules with sticky ends act as output detectors. Once set up, the liquid phase computer functions without additional intervention – though human intervention is needed to observe the final output molecules. See figure 2.

Other researchers have reported liquid-phase systems for DNA computing. Laura Landweber and her Princeton University colleagues' article in *Proceedings of the National Academy of Sciences* 15 February 2000 issue used a hybrid DNA-RNA computing system to compute solutions to a variant of a well-known chess problem. The "Knight problem" asks what configurations of knights can be placed on a chess board with n squares on a side such that none of the knights is attacking another. RNA strands with 10 bits (each bit represented by 15 nucleotides separated by 5-nucleotide spacers) were



optimization problems, convert it into DNA and use DNA's massive parallelism to search a large number of possibilities, with a chemical reaction to filter out the ones you don't want," says Erik Winfree of the California Institute of Technology in Pasadena. In contrast, much of the research underway in DNA computation is about self-assembly of structures, "gaining a different kind of control on molecular processes." Researchers in this field are "essentially using the idea of an algorithm in information processing—a specific set of rules that can be iterated to accomplish some task" and applying it to chemical tasks. "The task is now one in which you have chemical input—the components for the structure you want to build—and chemical output—the final structure," Winfree says. Because an algorithm is involved, the assembly can be viewed as a form of computation. "It's another case where the tools and concepts of computer science are brought to bear on how to solve the problem."

The self-assembly properties of DNA suggest an indirect application to computing, says Winfree. "For example, one thing that people think seriously about is how to create extremely small electrical circuits where the components are now on the molecular scale." At that scale, lithography, if feasible at all, would be horribly expensive. "Could you chemically synthesize the components of an electrical circuit, like the pieces of a jigsaw puzzle, toss them into a chemical reaction, shake it for awhile, and have the correct circuit pattern create itself?" he asks. On paper, it looks like some simple electrical circuits could be assembled in this manner. "The question becomes, can we use DNA as the mechanism for directing the self-assembly of these circuits?"

The concept of self-assembly, which biological systems have evolved to form such structures as viruses, flagella, and microtubules (which serve as structural and motile components of cells), can lead the way to using DNA as the basis of nanorobotics. DNA-tilings researchers see the opportunity to use self-assembly to form designer materials. Because DNA is found in two physically different forms (B-DNA and Z-DNA, depending on how the nucleotide chains coil), this suggests a mechanism for using DNA for nanorobotic actuators. Actuators that produce either rotational or translational motion have been demonstrated, but development of DNA actuators that do both have not. Thus, it appears that macromolecular computing is blurring the lines between computing, materials science, and robotics. At least at the molecular scale, it might be possible to use the same class of molecules to build, program, and operate molecular-scale devices whose applications have only been foreshadowed by science fiction. ■

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Who's THE Best?

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As computer architecture advances, it is becoming more and more difficult to compare the performance of various computer systems simply by looking at their specifications. Therefore, special tests, called Benchmarks, were developed that could be performed on different systems, allowing the results from these tests to be compared across different architectures.

COMPUTER hardware manufacturers need bragging rights in the same way people with fast cars boast about the fastest zero to sixty miles per hour rates or the highest top speeds. Having the fastest computer seems like a badge of honour. However, the computer industry moves too fast to keep up with the latest and the greatest. The most powerful personal computer today will become second best tomorrow when a newer, faster model arrives on the scene. Unless you plan on upgrading every few months, it is usually not worth the bother. Besides, unless you are working on heavy-duty graphics or 3-D games, you will not see the difference. Benchmarks are special programs that are used for the purpose of comparing performances of computer systems under different conditions. Benchmarks are run on the concerned systems and their test results are used for the comparison.

What is a benchmark?

A benchmark is a point of reference for a measurement. The term presumably originates from the practice of making dimensional height measurements of an object on a workbench using a graduated scale or similar tool, and using the surface of the workbench as the origin for the measurements.

In computing, a benchmark is the result of running a computer program, or a set of programs, in order to assess the relative performance of an object, by running a number of standard tests and trials against it.

How can it be used?

The term, benchmark, is also commonly used for the programs that are specially-designed for benchmarking. Benchmarking is usually associated with assessing performance characteristics of computer hardware. An example of this is the floating point operation

performance of a CPU. Arithmetic operations performed on real number tend to be computationally expensive and the faster they are executed, the more efficient the programs are. However, there are circumstances when the technique is also applicable to software. Software benchmarks are, for example, run against compilers to assess their efficiency at, for instance, optimising compiled programs and reducing their code size.

From this view, benchmarks provide a very efficient method of comparing the performance of various components of a computer system across different hardware architectures. For example, Intel Pentium 4 processors have a higher hertz rating than AMD Athlon XP processors for the same computational speed, in other words a 'slower' AMD processors could be as fast on benchmark tests as a higher hertz rated Intel processors.

How do they work?

Benchmarks are designed to mimic a particular type of workload on a whole computer system of a specific component of the system. According to the applications they represent, benchmarks can be divided into two categories. Synthetic benchmarks are composed of specially-created programs that impose the workload on the component; and application benchmarks run actual real-world programs on the system.

Synthetic benchmarks are better suited for testing out individual components, like a hard disk or networking device. Application benchmarks, on the other hand, give a much better measure of real-world performance on a given system. They can be subdivided into different types:

1. Real programs: for example word processing software, tool software such as CAD programs or user's application software.
2. Kernel programs: these are parts abstracted from other real programs. They only contain the core part of the program code,
3. Toy Benchmark are user-written programs that are used test the computer's basic components.

Beware!

Computer manufacturers have a long history of trying to set up their systems to give unrealistically high performance on benchmark tests that is not replicated in real usage. For instance, during the 1980s some compilers could detect a specific mathematical operation used in a well-known floating-point benchmark and replace the operation with a mathematically-equivalent operation that was much faster.

These transformations are rarely useful outside the benchmark and manufacturers commonly report only those benchmarks (or aspects of benchmarks) that show their products in the best light. They also have been known to misrepresent the significance of benchmarks, again to show their products in the best possible light. Taken together, these practices are called benchmarking.

Users are recommended to take benchmarks, particularly those provided by manufacturers themselves, with ample quantities of salt. If performance is really critical, the only benchmark that matters is the actual workload that the system is to be used for. If that is not possible, benchmarks that resemble real workloads as closely as possible should be used, and even then used with scepticism. It is quite possible for system A to outperform system B when running a program P on workload X and the order to be reversed with the same program on your own workload. ■

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The Evolution of a BRIDGE to Religion

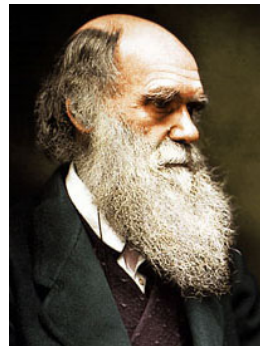
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Evolution has been advocated as a scientific discipline for decades; its influence has spread throughout the biological sciences, and gained momentous support. One aspect of human existence, religion; however, is still arm wrestling this monster of evolution. The truth of the matter is that the champions of religion and evolution are at wars due to their convictions, not evolution and religion *per se*. This has reflected badly on both sides, religion has been painted as anti-intellectualism and evolution as a pseudoscience. There must be a way to make them communicate and co-exist in our society, minds and hearts; they do defend different types of truths, to the religious, religion is an absolute truth source and evolution is relative and vice versa for the evolutionist. By maintaining the two definitions of truth clear, one can be religious and study evolution; and explore religion even as an evolutionist. This is likely to bridge a gap between science and religion, and melt down misconceptions.

EVOLUTION is an idea that has gained huge momentum in recent decades among scientists and the general public alike. It is a unifying theme for different disciplines from astrophysics to zoology spanning most of human scientific knowledge. The idea suggests a mechanism for the appearance of life on earth and the means responsible for producing the huge biodiversity that we see around. The grandeur of this theory is rivalled only by the unified physical theory and is at the forefront of life science research. Its main aim is the foundation of natural laws and rules that govern biotic existence and its dynamics. It therefore has drawn a lot of attention from philosophy and has both long standing admirers and loathers. All approaches thus far linking the theory to the religious beliefs have been negative in outcome and sterile in methods. Probing these two giants of human existence reveals some misconceptions and overstatements. The theory of evolution does not in any sense provide evidence for the non-existence of god but the scientists themselves who have clear and rooted beliefs about god. Because of the association of



Left:
Charles Darwin

we do not want to try harder. The only way forward is to use both religion and science objectively to achieve a coherent and productive way of life. Is this not the message of the prophets of science and religion?

“The theory of evolution does not in any sense provide evidence for the non-existence of god”

evolution with atheism, most scientists attracted to its study are atheists or become atheists (Larson and Witham 1997. Larson and Witham 1998. The studies are about biologists in general.)^{*1} and ^{*2}. Evolution has therefore turned its back on religion and vicious non-scientific battles erupted. The scientific arguments against religion were swallowed by the media and grotesquely overstated to show that everything in the theory has been proved and the burial of god is imminent. When considering the law of cause and effect (a pillar of the scientific methodology), we find that there is always a need for the first action that starts the cascade. There is also a need for organising the rules and laws. Observing carefully the phenomena of nature we find fine-tuning, complexity, organisation, wisdom and beauty. Having said that, we should not stop at the first cause or explanation of natural phenomena and provoke the creator whenever

Evolution as a scientific theory

Charles Darwin (1809-1882) produced his hypothesis that living organisms change into new organisms after observations made on the natural world from his voyages. He concentrated on examples of variation between individuals, and did not dwell much on the origin of species (Rose, 2001). He suggested that differences in characters (traits) between species could become fixed over time resulting in new species divergence (speciation). He then analysed some of his findings using comparative methods. In the case of the finches, for instance, he noticed that different species of birds have different beaks and that the beak size and shape (a character or phenotype) correlates with the diet (e.g. small ones for insectivores and strong ones for herbivores). He suggested that this adaptation is due to natural selection acting on beak dimensions. In theory, the two species were once one species which has been pushed to two extremes because of varying diet conditions. In the jungle insects are plentiful and some members of the original species started evolving beaks to suit their new brittle diet. In another semi-arid place the same individuals could develop harder beaks in order to survive on hard food. Over generations, the two

from a scientific point of view this (finches' evolution) is a hypothesis that needs proving and not proof that evolution happened

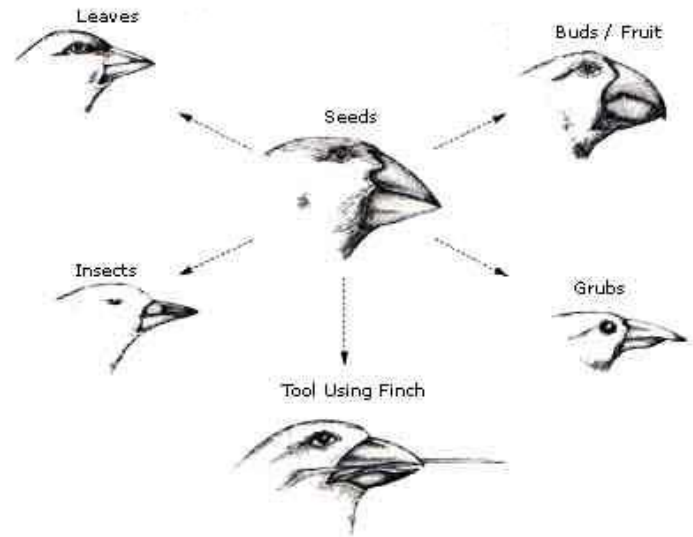
species would develop other characters and become distinct from their original group. This was Darwin's explanation for the existence of two species populations of finches in different neighbouring islands of the Galapagos archipelago. In doing so Darwin has suggested that selection only chooses the best and fittest from the population available but does not induce the formation of new characters. This is, however, an interpretation of the data and not a proof. Therefore, from a scientific point of view this is an hypothesis that needs proving and not proof that evolution happened. Scientists and the general people either adhered to his view and accepted the truth of the claim or did not.

In the 1930s and 1940s the new synthesis was born, championed by scientists who attempted to reduce the theory to easily researchable chunks (Kutschera and Niklas, 2004). They based their new theory on mathematical models, empirical studies and advances from different disciplines such as population biology, genetics, ecology, zoology and palaeontology. The champions of this era were, to name a few, Ernest Mayr, Theodosius Dobzhansky, Ronald A. Fisher, George G. Simpson, and John B. Haldane. They provided mathematical models for natural selection, proposed new evolutionary mechanisms (sexual selection, founder effect evolution); incorporated Mendelian inheritance into the theory of evolution, tried to define species and started investigating the origin of species. These achievements have been the cornerstones of research in evolutionary biology by providing the subjects that could be addressed and the means to do so.

In the 1970's a new breed of evolutionists isolated questions in the theory and provided some unorthodox solutions. John Maynard Smith showed a huge cost to sex and questioned how sex evolved and its evolutionary benefits. He also touched on animal behaviour (altruism) by applying game theory to animal interactions (Maynard-Smith, 1982). Robert Trivers also suggested a theory of reciprocal altruistic behaviour to explain the evolution of altruism and used it to study social insects (Trivers and Hare, 1976). Building on earlier work on group and individual selection, Richard Dawkins proposed in his book 'The Selfish gene' that selection occurs at the level of the gene and visualised genes as entities with clear 'minds' and intentions (Dawkins, 1976). After analysing the fossil records, Stephen J. Gould proposed that evolution may not have happened gradually, but in bursts. He termed this theory punctuated equilibrium (Eldredge and Gould, 1997). In the next three decades huge advances were made because of advancement in molecular biology and other biological disciplines, and evolutionists have used these sciences to show the mechanisms of evolution working at the molecular level (protein evolution, genetic view of species).

The mechanisms of evolution

The first mechanism that Darwin and Wallace proposed for evolution is natural selection (Darwin and Wallace 1858). In its abstract form, natural selection is a blind and passive force that works by choosing the best group or individual fitted for the conditions available. In a population where conditions do not change natural selection will not act. If the changes are sudden natural selection is too slow to act. The role of natural selection in speciation is to allow variation and therefore functions as a stabilisation force, as explained above in the Galapagos finches (Schneider, 2000). In sexual species another force is in action: sexual selection. In these species, males compete for females and females choose the best males (e.g. most ornamented) for mating, as illustrated by the behaviour of peacocks. After generations the males become more ornamented and the females' preference behaviour is so exaggerated that they can no longer mate the original population (Fischerian runaway hypothesis) and new species is born (Edwards et al., 2005). These two mechanisms are widely accepted as the main drivers of evolution and substantial evidence have been accumulated in support of their collaborations in evolutionary dynamics (Carvalho et al., 1998). They have been applied successfully in breeding, conservation of natural habitats, and behavioural sciences but their roles in speciation are based on inference from already divergent species and mathematical models (Gourbiere, 2004). To put it another way, species have already diverged and exists today as two separate entities and assuming that evolution is the causing factor, what causes are to account



Above:
Darwin Finches

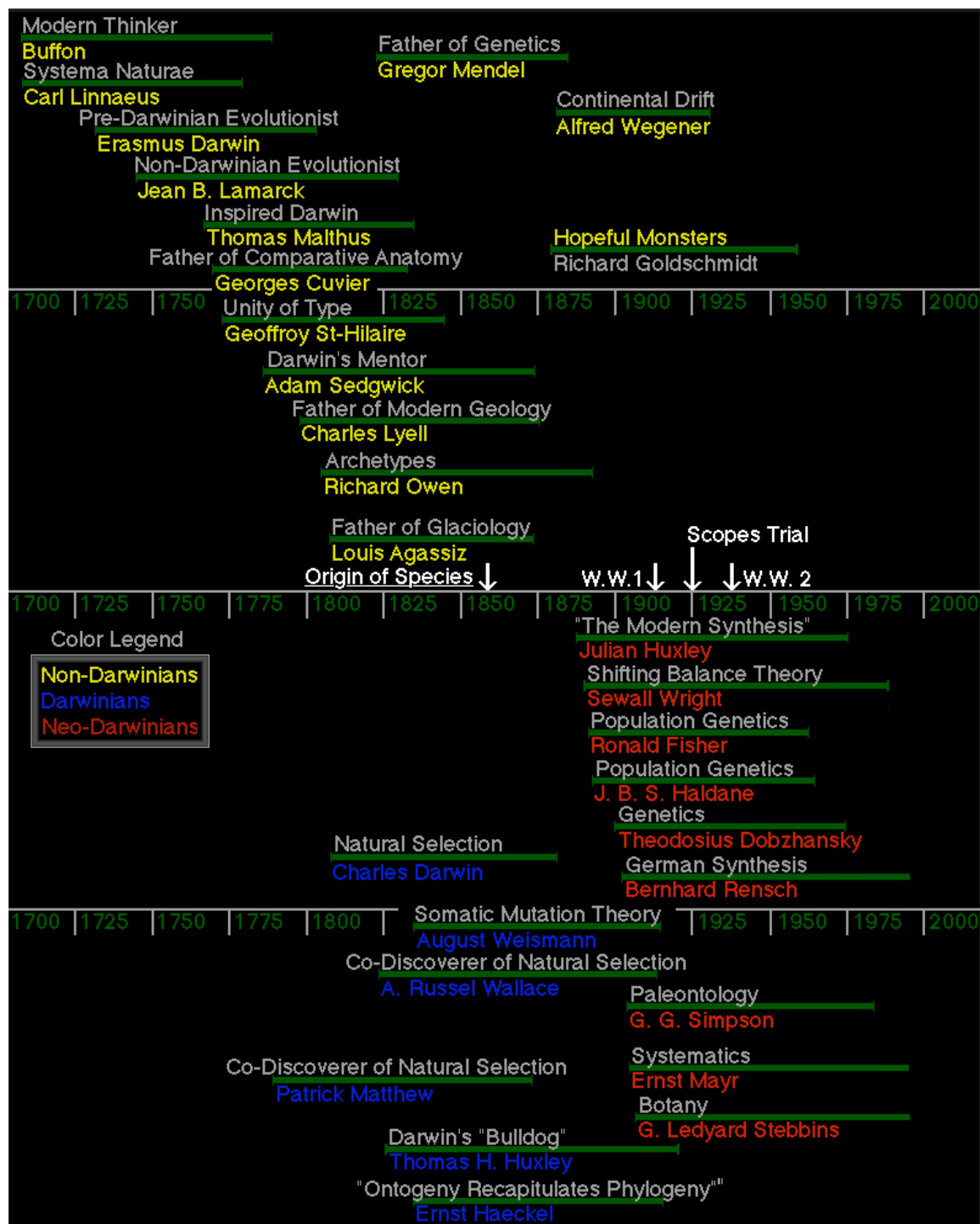
for the appearance of two species. Using mathematical modelling, we can infer that given certain conditions, the two species found at present can result from one species adapting to different conditions.

Another force that mathematical models have blessed is random genetic drift, which can be explained by the following scenario: in a population of species, a mutation occurs in one generation, giving its bearers an advantage to mate and reproduce. This mutation is then fixed by the process of natural selection and passed on to later generations. After generations this mutation will cause isolation of its bearers from the original population. The new population forms a new species (Barton, 1996). This force is random and time consuming. It also has the disadvantage that most if not all mutations are deleterious (Kondrashov, 1995) and is believed to play a minimal role in speciation. An alternative hypothesis has been recently proposed by Naoyuki Takahara: the neutral theory of evolution. In this model the changes at the DNA do not affect the protein or RNA produced (i.e. are not mutations) but are still inherited through the generations. These changes are silent or neutral hence the name. This theory is believed to be the main driver of protein and chromosome evolution (Takahata, 1996). In the two last models the changes are not in the phenotypes first (characters) as the beak size or ornaments, but are in the genotype (genes responsible for the characters). These mechanisms are used collaboratively sometimes to explain the evolution of some traits and characters and maybe more will be discovered as science advances. They are also at the mercy of the inferences that we make from available species and may have not been applicable before species diverged, if we can prove for certain that they did.

The religious clauses

In religion (and Islam in particular) there are different levels of truths: the absolute and relative truths. The absolute truth is communicated through God (Allah). This truth is the main belief in Islam and without it the other pillars of Islam cannot be built. Humans are not yet pursuing the advancement of science to prove these pillars. They are eternal truths that cannot be proved wrong, and they have not. That angels exist, heaven exists and hell exists are all eternal truths. Allah also is the creator of all things we see around us. This is a belief and it cannot be disproved. A belief is not needy of a proof but can only be reversed by a proof. That Allah exists is a belief and can only be reversed by proving otherwise. In this sense atheism is a belief system as well. In addition, humans need to believe in something, otherwise they will believe in anything².

They (mechanisms of evolution) have been applied successfully in breeding, conservation of natural habitats, and behavioural sciences but their roles in speciation are based on inference from already divergent species and mathematical models



Left:
The Evolution Timeline

The second form of truth is relative truth. In this truth proof is needed to accept it, and a proof can discredit it. Saying that sea water is salty is a relative truth that can be proved by taste. These truths are limited in many different ways. There are a limited number of ways to prove anything at least in practice. The truth that we are studying is inferred from other relative truths that are not proven but are socially accepted (e.g. Alien abduction requires the proof for alien presence). Because these truths are limited by the proof burden, they are restricted and we can build on them only if they are proved.

The scientific truth is a relative truth that adheres to certain principles and laws to govern its progress and circumvent its disillusion. Some philosophers argue that scientific truth can never lead to ultimate truth but it is certainly the most reliable⁴³.

The battleground of the two sides

Evolution is a science based upon relative, and not absolute, truths. Its implications are never ultimate truths but debatable until we get to the bottom of the theory. As we have established, some research themes in evolution have advanced at a very high pace but still we are looking for mechanism and tools to explain how speciation might have happened,

assuming it happened at all. The plain truth is that we do not know the forces responsible for speciation.

In that sense evolution is not looking for ultimate truth and is definitely not competing with religion. There seems to be no disagreement between evolution and religion. Evolution is looking for truths that are not finalised. Religion on the other hand state that god created the universe. Evolution does not prove the non-existence of god.

Evolutionists may be, and the media may want to be, but no scientific discipline is trying to be pro- or anti-religious. Science is just trying to teach us to learn more from around us and so is religion. The human factor of religion and evolution (i.e. the people that represent them) want to clash, not the two disciplines themselves. The cases for both religion and evolution are clear. There is no definite empirical proof that species evolve all there are only inferences from evidence of different mechanisms that lead to evolutionary variations (Machado et al., 2002; Osada and Wu, 2005). All the mathematical models and computational simulation are based on few specific assumptions because of the limited knowledge about the factors of speciation (Coyne and Orr, 1998; Kelly and Noor, 1996; Orr, 1995). This is not to say that microevolution (forces) occurs but macroevolution (origin of species) does not. The link between the two is

These mechanisms are (...) at the mercy of the inferences that we make from available species and may have not been applicable before species diverged.

not established, and there are questions still to be answered. For example How can natural selection, sexual selection, or molecular selection drive speciation? These are questions that have been attempted many times, but to no avail. The holy grail of evolution has never been found. Evolutionary biologists infer from their observations, like any other scientists in general - biologists in particular. Evolutionary theory, however, is a much harder code to crack. No one has seen organisms evolving although many experiments have been conducted on bacteria, yeast and flies with no speciation occurring. The mistake could be in the definition of species (the species concept is still a hotly debatable topic) and no major improvement has been noticed since Ernest Mayr proposed the Biological Species Concept (BSC) in 1942. It may also be the way we approach the topic of speciation (Wiens, 2004). Another interesting topic that is neglected is species differentiation, where species evolve but do not become new species. We as yet do not know how frequent this phenomenon is, or how to approach it to analyse its differences from speciation (Magurran, 2001).

The case for or against evolution should never occur. Can you imagine a case for relativity theory or quantum physics? Not forgetting that most historians of science blame Einstein for the non-belief in quantum physics because he objected to its mind dazzling implications. Neither of these theories got into trouble with religion. On the contrary, religious scholars praise these two branches of science. So why should evolution be the exception? Evolution has all it needs: a long geological time, a genetic theory that can support it, and a natural world that is a lab of evolutionary dynamics. But it needed more or more accurately its champions have a strong feeling against god (Larson and Witham 1998). In a documentary about evolution and religion, Richard Dawkins was asked, "Why not say that god started the whole universe?". He answered by saying it is too lazy to provoke a creator when we run out of options. Well, this is a good point but what makes him so sure that god did not play any role in it in the first place? Or is He the one who devised natural selection, sexual selection or molecular selection? We do not know the answer. Natural phenomena are not easy to explain. Newton proposed gravity but it was never understood until Einstein and his mind blowing explanation. Did god play a role in devising gravity? We do not know. I believe He did. Others believe that He did not. It boils down to belief.

The human factor of religion and evolution (i.e. the people that represent them) want to clash, not the two disciplines themselves

The bridge

Evolution has been treated badly by religious people and has not been given its fair chance to be heard, it retaliated by claiming its overstated status should be regarded as science and taught in schools. Is their any religious argument not to study evolution? The answer is no. Is there any problem in sticking to a scientific theory (its ups and downs)? Yes. Cosmology, for example, has been revolutionised in recent decades by the Big Bang theory (New Scientist, May 22-28 issue, 2004, p. 20). Other theories have been proposed due to the shortcomings of the Big Bang model (e.g. the quasi-steady-state theory) but we hardly hear of them⁴. They have their flaws but may be a new theory is needed to explain more things about the birth of the universe. In the same way in biology, evolution is the only proposed theory and has no scientific alternative until recently, with the development of the intelligent design (ID) theory (this theory suggest the presence of a creator). This theory wants to be granted scientific blessing as it has already had religious blessing. Some of its champions are known scientists and philosophers that have objected on the theory of evolution. Taking sides at present is not wise but both theories answer the same questions. Hence they are competing theories but ID is a baby and organic evolution is the old established player. Still, this does not bridge the gap between evolution and religion. It is only regarded as a religious evolutionary theory (Dembski, W.A., and Ruse, M. (Eds). 2004).

The arguments against religion and evolution are philosophical, moral or ethical. We are not as scientists concerned about the philosophical meaning of a gene or the implications of our creation. We are only hoping to explain natural phenomena by laws and roles that we can use to advance our knowledge and applications of the resources at hand. Religion on the other hand searches for spiritual and material comfort: it is a way of life. Religion is the platform and science is the tool to build, so how can they engage in wars? They do not. The champions of each discipline do, however. Imagine then the river of knowledge and wisdom, which have all the different kinds of truths. Religion is on one bank trying to scoop the knowledge through religious scholars and evolution is on the

In the last decades they (evolutionists and their opponents) have been throwing stones at each other in unmerciful wars but now it is time to build a bridge out of the next ammunition

other side doing alike. In the last decades they have been throwing stones at each other in unmerciful wars but now it is time to build a bridge out of the next ammunition. This bridge allows us to understand the limits of science and the openness of religion. Only then we can advance in a civilised place where science and religious studies thrive side by side. ■

References

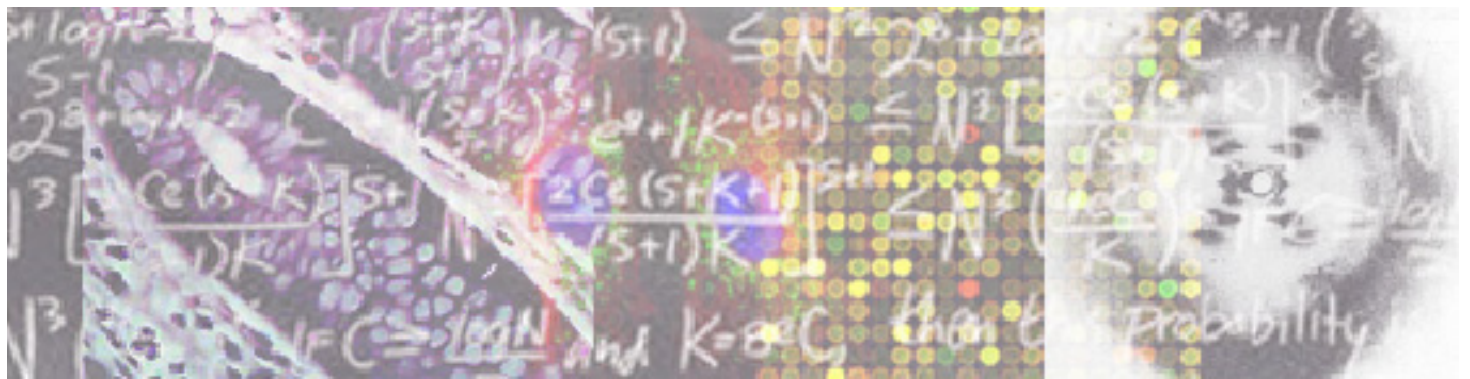
- Barton, N. H. (1996). Natural selection and random genetic drift as causes of evolution on islands. *Philos Trans R Soc Lond B Biol Sci* 351, 785-794; discussion 795.
- Carvalho, A. B., Sampaio, M. C., Varandas, F. R., and Klaczko, L. B. (1998). An experimental demonstration of Fisher's principle: evolution of sexual proportion by natural selection. *Genetics* 148, 719-731.
- Coyne, J. A., and Orr, H. A. (1998). The evolutionary genetics of speciation. *Philos Trans R Soc Lond B Biol Sci* 353, 287-305.
- Darwin, C. and Wallace, A. On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection. *Journal of the Proceedings of the Linnaean Society, Zoology* 5, 45-62.
- Edwards, S. V., Kingan, S. B., Calkins, J. D., Balakrishnan, C. N., Jennings, W. B., Swanson, W. J., and Sorenson, M. D. (2005). Speciation in birds: Genes, geography, and sexual selection. *Proc Natl Acad Sci U S A* 102 Suppl 1, 6450-6457.
- Eldredge, N., and Gould, S. J. (1997). On punctuated equilibria. *Science* 276, 338-341.
- Gourbiere, S. (2004). How do natural and sexual selection contribute to sympatric speciation? *J Evol Biol* 17, 1297-1309.
- Kelly, J. K., and Noor, M. A. (1996). Speciation by reinforcement: a model derived from studies of *Drosophila*. *Genetics* 143, 1485-1497.
- Kondrashov, A. S. (1995). Contamination of the genome by very slightly deleterious mutations: why have we not died 100 times over? *J Theor Biol* 175, 483-494.
- Kutschera, U., and Niklas, K. J. (2004). The modern theory of biological evolution: an expanded synthesis. *Naturwissenschaften* 91, 255-276.
- Larson, E.J., and Witham, L. Leading scientists still reject God. *Nature* 394, 313-313.
- Larson, E.J., and Witham, L. Scientists are still keeping the faith. *Nature* 386, 435-436.
- Machado, C. A., Kliman, R. M., Markert, J. A., and Hey, J. (2002). Inferring the history of speciation from multilocus DNA sequence data: the case of *Drosophila pseudoobscura* and close relatives. *Mol Biol Evol* 19, 472-488.
- Magurran, A. E. (2001). Sexual conflict and evolution in Trinidadian guppies. *Genetica* 112-113, 463-474.
- Maynard-Smith, J. (1982). The century since Darwin. *Nature* 296, 599-601.
- Orr, H. A. (1995). The population genetics of speciation: the evolution of hybrid incompatibilities. *Genetics* 139, 1805-1813.
- Osada, N., and Wu, C. I. (2005). Inferring the mode of speciation from genomic data: a study of the great apes. *Genetics* 169, 259-264.
- Rose, S. (2001). Alas, poor Darwin. *Biologist (London)* 48, 100.
- Schneider, C. J. (2000). Natural selection and speciation. *Proc Natl Acad Sci U S A* 97, 12398-12399.
- Takahata, N. (1996). Neutral theory of molecular evolution. *Curr Opin Genet Dev* 6, 767-772.
- Trivers, R. L., and Hare, H. (1976). Haplodiploidy and the evolution of the social insect. *Science* 191, 249-263.
- Wiens, J. J. (2004). What is speciation and how should we study it? *Am Nat* 163, 914-923.

Further reading and cited books

- Figliucci, M. 2002. *Denying Evolution: Creationism, Scientism, and the Nature of Science*. Sinauer Associates, Inc.
- McGrath, A. 2005. *The twilight of atheism*. Oxford University Press.
- Kirkham, R. L. 1992. *Theories of Truth: a Critical Introduction*. Cambridge: MIT Press.
- Coles, P. and Lucchin, F. 1996. *Cosmology: The Origin and Evolution of Cosmic Structure*, John Wiley & Sons Ltd.
- Dawkins, R. 1976. *The Selfish Gene*. Oxford University Press.
- Dembski, W.A., and Ruse, M. (Eds). 2004. *Debating Design: From Darwin to DNA*. Cambridge University Press.

A Short Story:

Cancer from Genetics... to Mathematics



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THE Roman doctor Galen (A.D. 131-201) like many of the best physicians of the Roman Empire was a Greek. Galen wrote that cancerous veins extend out from the disease site like the claws of a crab. This old observation gave the basis for a simple definition for cancer: "A disease manifested by cellular overgrowth (neoplasia), with a loss of tissue structure (anaplasia), and a potential to spread (metastases), resulting in a loss of tissue function".

Cancer and the Reductionist Approach

The story of cancer is far from being short because cancer is a disease with a multifactorial aetiology (primary causes), a complex pathology, and most importantly it occurs in multistep fashion (Figure 1). As for many others phenomena, the long story of cancer can be cut short by means of the reductionist approach¹. Generally the reductionist approach, as the name suggests, favours the simple events and observations to the more complex ones¹. The beauty of using such an approach relies in its ability to provide more easily interpretable, though relatively accurate and reliable information. The implication of the reductionist approach in cancer biology made it widely accepted that cancer is primarily a genetic disease that arises because of mutations in cancer susceptibility genes². These genes, which include gatekeepers, caretakers and landscapers³, normally orchestrate to maintain the normal biology of the cell. This does not undermine the involvement of environmental factors in tumorigenesis. In fact, these factors contribute to tumorigenesis by interference with any of the three gene families mentioned above.

Cancers Starts at Genetics

Gatekeepers directly regulate growth and differentiation and comprise oncogenes (growth enhancers) and tumour suppressor genes (growth inhibitors), which when mutated provide a direct cellular growth advantage⁴. Caretakers, in contrast, promote tumour genesis indirectly. They function in maintaining the genomic

“A disease manifested by cellular overgrowth (neoplasia), with a loss of tissue structure (anaplasia), and a potential to spread (metastases), resulting in a loss of tissue function”

integrity of the cell, hence mutations in caretaker genes can lead to genomic instability, which in turn results in a rapid accumulation of changes in other genes that directly control cell both and death⁴. Similar to caretakers, landscaper genes do not affect cellular growth directly, but generate an abnormal environment that contributes to the neoplastic transformation of cells⁵. The alteration of one gene, however, is generally believed to be insufficient to give rise to full blown cancer. For progression towards malignancy, further mutational hits are necessary^{6,7}. In other words cancer results from a combination of initiating

and promoting events, which accumulate along with the tumorigenesis process.

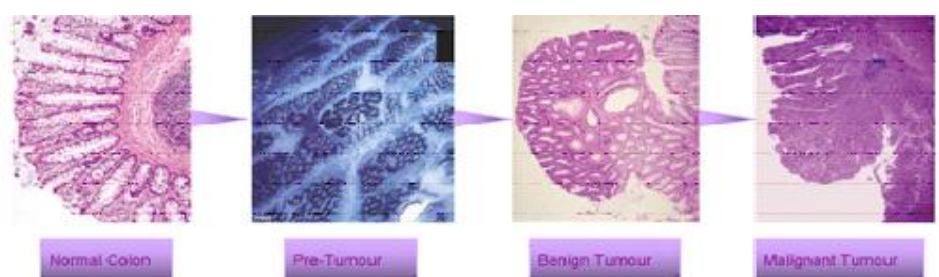
Cancer: Genetics, Cell Biology and Physiology

The power of genetics provided a fairly meticulous understanding of the genes involved in cancer initiation and promotion. When considering the Central Dogma in biology, mutation in genes translate to faulty proteins with defects in their abundance, distribution, structure or function. At the cellular level, proteins cooperate with each other and with other molecules to fulfil a biological role, so when defective they can cause a compromised cooperation. This results in altered cellular function. Clearly, cells are not present in isolation; they function within tissue by interacting and communicating with neighbouring cells. In the case of cancer, cellular defects can lead to perturbation of tissue integrity, which can be usually assessed by looking at histological specimens. Perturbations in tissue integrity can interfere with the role of the organ and subsequent loss of function. This, once again, represents the importance of the Bottom-Up effect in biological systems, where the input in the lower level influences the outcome at the higher level; genes, proteins, cells, tissues, organs and organisms (Figure 2).

In a simple scenario, for a cancer to develop, cells have to overcome six challenges. These challenges include: procession of a growth advantage, ability to escape cell death, acquisition of self-sufficiency for growth signals, ability to induce new blood vessels formation, capability to

Below:

Figure 1 Progression of Colon Cancer "Adenoma Carcinoma Sequence". Histological appearance of colon tissue at different levels of cancer development. The normal colon is organised to form crypt structures with stem cell at the bottom of the crypt, the proliferating and differentiating cells in the middle and dying cells at the top. This homogenous structure is lost during tumour progression, and completely disappears in the malignant tissue (carcinoma).



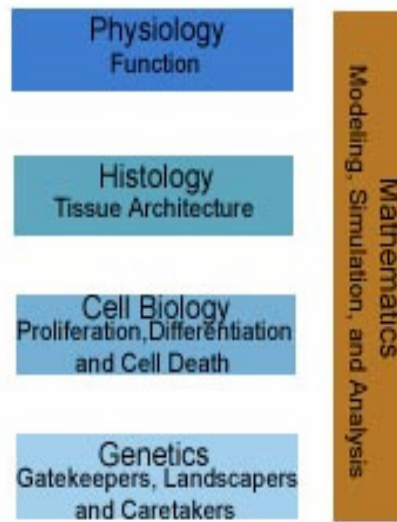
Right:

Figure 2. A simple Bottom-up Effect that has implication in cancer biology. Mathematics can potentially be employed at any level within this system.

migrate, invade and spread, and finally surviving in the new environment away from the niche².

Cancer Biology and Mathematics...When?

Cancer progression is a dynamic process, with many players on various grounds. A quantitative understanding of cancer can be facilitated using a mathematical framework that describes the principles of population genetics that governs tumour initiation and progression^{8,9}. Mutation, selection and tissue organization can certainly be modelled mathematically, and this would have great impact in the analysis of current experimental data as well as in assisting in putting forward new hypothesis. ■



References

1. Williams, N. Biologists Cut Reductionist Approach Down to Size. *Science* 277, 476-477 (1997).
2. Vogelstein, B. & Kinzler, K. W. The Genetic Basis of Human Cancer (McGraw-Hill, 1998).
3. Kinzler, K. W. & Vogelstein, B. Gatekeepers and caretakers. *Nature* 386, 761-763 (1997).
4. Sieber, O. M., Heinemann, K. & Tomlinson, I. P. Genomic instability-the engine of tumourigenesis? *Nature Rev Cancer* 3, 701-708 (2003).
5. Bissell, M. J. & Radisky, D. Putting tumours in context. *Nature Rev Cancer* 1, 46-54 (2001).
6. Muller, H. J. Artificial transmutation of the gene. *Science* 46, 84-87 (1927).
7. Knudson, A. G. Two genetic hits to cancer. *Nature Rev Cancer* 1, 157-162 (2001).
8. Knudson, A. G. Mutation and cancer: statistical study of retinoblastoma. *Proc. Natl Acad. Sci. USA* 68, 820-823 (1971).
9. Moolgavkar, S. H. & Knudson, A. G. Mutation and cancer: a model for human carcinogenesis. *J. Natl Cancer Inst.* 66, 1037-1052 (1981).
10. Cairns, J. Mutation selection and the natural history of cancer. *Nature* 245, 197-200 (1975).
11. Frank, S. A., Iwasa, Y. & Nowak, M. A. Patterns of cell division and the risk of cancer. *Genetics* 163, 1527-1532 (2003).
12. Frank, S. A. & Nowak, M. A. Cell biology: developmental predisposition to cancer. *Nature* 422, 494 (2003).

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Modelling life

The birth of computational biology

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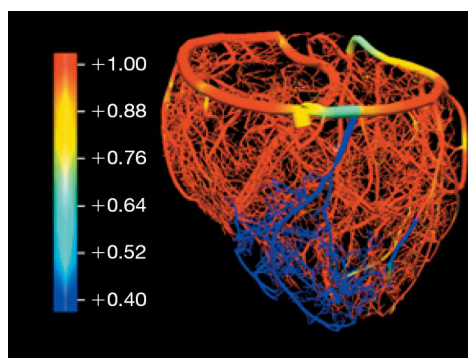
CLASSICAL bottom-up approach in biology has led to a spectacular success in the last fifty years or so. In a more or less reductionist fashion, scientists have tried to investigate simple building blocks in the cell which when put together, could give a comprehensive view about various life processes. The structures of DNA and numerous other macromolecules were solved, and the sequences of entire genomes from a number of organisms were determined. As more and more of this data accumulates, the challenge for many years to come is to interpret and exploit such large-scale information.

Simulating the complete functioning of an organism based on genetic information may be a tempting experience. Noble prize winner Francis Crick once wrote "You, your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules."¹ On the other hand, another Nobel Laureate, Sydney Brenner, put it "I know one approach that will fail, which is to start with genes, make proteins from them and to try to build things bottom-up."² This latter view is probably more realistic for a number of reasons. First, computational power is a big problem. Even, with the most powerful computer on Earth, IBM's \$100 million *Blue Gene*, it can take months if not a year to reconstruct the process of folding of a single polypeptide chain to its three-dimensional structure which determines its function. The exhaustive reconstruction of processes in a single cell which contains typically 10^{12} proteins will need strikingly 10^{27} *Blue Genes*. Second, biological systems are extremely interactive at various levels from gene expression and protein synthesis to the organism's physiology and behaviour. Nevertheless, the reductionist and integrationist camps would agree on one point: No matter how the causation runs, biological systems are highly complex. Beyond a certain level of complexity the qualitative approach becomes insufficient, and the need for quantitative mathematics-based approaches becomes more apparent (To get a flavour, read How O'ReillyTM Perl Saved the Human Genome Project by Lincoln Stein¹⁰).

Using models to understand extreme complexity: the human heart

Whole new areas of so called *Computational Biology* have recently emerged. They generally rely on both computational and rigorous mathematical methods to tackle biological problems. Systems Biology, one well known example, is concerned with building models and simulations for whole biological systems at various levels from molecules to organs⁹.

O'ReillyTM Perl Saved the Human Genome Project



Above:

Model for coronary circulation. The constriction of one of the main branches leads to blocked blood flow (blue regions)⁷. Rapid flow is indicated in red and slow flow in blue. This model forms basis for identification of regions of ischaemia⁸.

For instance, models have been generated for an incredibly complex organ: the human heart. This was done at two different levels: cellular and organ.

At the cellular level, basic experimental knowledge about various proteins such as ion transporters, force generators and reaction catalysts was used to recreate *in vivo* scenarios for different heart excitable cell types and their associated gene expressions patterns³. At the organ level, an anatomical model was built and the spread of excitation through it was simulated⁴. Furthermore, it was integrated into a theoretical electrical environment representing the tissues of the upper part of human body⁵. This has led to a remarkable anatomical and fluid dynamic modelling of the coronary circulation (Figure 1). Linking these two levels, cells to organs, has enabled the reconstruction of pacemaker behaviours, the electrocardiogram⁶ and various disease states such as some of the life-threatening cardiac arrhythmias. Obviously, this may have potential applications in the pharmaceutical industry and clinic. Nearly half of the drug withdrawals in recent years are due to cardiac side effect, and such models could open doors to *in silico* drug-safety testing.

Theoretical biology on the horizon?

Despite the prospects computational biology may present, it is changing the way modern biologists are thinking in an unprecedented manner. This has great impact on the future of a whole spectrum of life sciences. Although many scientists often use the terms 'computational biology' and 'mathematical biology'

interchangeably, these two terms have in fact two different meanings. The latter refers to a branch of mathematics which looks for mathematical solutions i.e. generalisations which set ground for theories. On the other hand, computational biology seeks for particular numerical results. Mathematical biology is well established in many areas of biology ranging from biochemical reactions to the function of the nervous system.

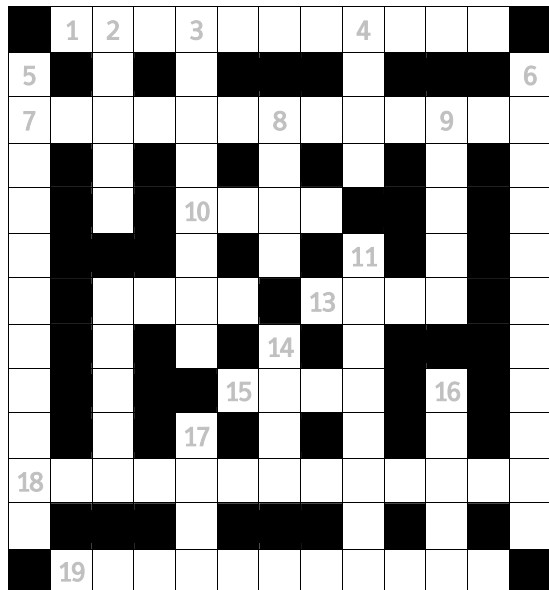
Nevertheless, we can not, at this stage, talk of a 'theoretical biology'. The main reason is that in modelling biology, all we do is apply basic theories of chemistry and physics. There are biological data in such models but it makes no sense to say that the equations used come from a theoretical biology. Moreover, we still have not resolved fundamental questions within the central theory of biology "Evolution". If evolution continues to be viewed as consequences of contingent events, then a level of detailed description will always remain at the heart of biological computation. However, if we start emphasising on searching for some first principles of 'logic' in life, these would become the basis of a fully theoretical biology. This might occur in several ways. The first most secure of these is the 'jigsaw' method where the putting together of enough pieces of a whole organism is likely to reveal a design pattern which could indicate biological laws (coming back to reductionism!). The second solution may be extreme. It relies on the appearance of a biological 'Einstein' who will dissect the central theory of life. It is encouraging to see how many excellent mathematicians are drifting to this field. The 21st century could well whiteness the consummation of the marriage of mathematics and biology. ■

References

1. Crick, F.H.C. (1994) *The Astonishing Hypothesis: The Scientific Search for the Soul*, Simon and Schuster, London
2. Novartis Foundation (2001) *Complexity in Biological Information Processing*, Wiley, Chichester
3. Antzelevitch, C., Nesterenko, V.V., Muzikant, A.L., Rice, J.J., Chien, G. and Colatsky, T. (2001) *Phil. Trans. R. Soc. London Ser. A* 359, 1201-1216.
4. Noble, D. (2004) *Physiology* 19, 191-197.
5. Bradley, C.P., Pullan, A.J. and Hunter, P.J. (1997) *Ann. Biomed. Eng.* 25, 96-111.
6. Muzikant, A.L. and Penland, R.C. (2002) *Curr. Opin. Drug Discov. Devel.* 5, 127-135.
7. Smith, N.P., Pullan, A.J. and Hunter, P.J. (2001) *SIAM J. Appl. Math.* 62, 990-1018. Ch'en, F.C., Vaughan-Jones, R.D., Clarke, K. and Noble, D. (1998) *Prog. Biophys. Mol. Biol.* 69, 515-537.
8. Kitano, Hiroaki, (2002) *Science* 295: 1662-1664.
9. URL: http://www.bioperl.org/GetStarted/tj_ls_bio.html

Scientific Crosswords

Suggested by: Sofiane Naci



ACROSS

DOWN

1. English mathematician, (1642-1727), who developed the differential calculus, amongst many other great achievements. (5,6)
7. This principle states that the the total energy of a bulk of molecules is evenly distributed amongst the degrees of freedom of the molecules. (13)
10. One of the two beams of light produced by a birefringent material, and which is preferentially transmitted by 'Polaroid' materials. (1-3)
12. Noble gas whose name derives from the Greek word for 'new'. (4)
13. A system of moving parts designed to transfer motional energy often with a variable velocity ratio. (4)
15. Unit of electrical potential which is equal to one joule per coulomb. (4)
18. Light-sensitive metal halide used in photography. (6,7)
19. Instrument used to measure temperature. (11)

2. Low value resistor placed in parallel with an ammeter to alter its range. (5)
3. English physicist, (1892-1965), who found ionised layers in the atmosphere at an altitude of about 250 km. (8)
4. Sudden cessation of forward motion followed rapidly by motion in a reverse direction, cause of many automobile injuries. (4)
5. American electrical engineer, (1873-1961), who invented the thermionic triode. (3,2,6)
6. Greek philosopher, (610-546), who postulated that the earth was curved (but not round), to account for the horizon. (11)
8. Type of mirror image that can be cast onto a screen. (4)
9. Nickel-iron alloy of low thermal expansivity. (5)
11. Sugar which rotates the plane of polarised light clockwise as seen by an observer facing the light source. (8)
12. Scottish physicist, (1768-1851), who used a crystal prism to polarise light. (5)
14. Sealed metal container in which fuels are ignited to determine their heats of combustion. (4)
16. The old c.g.s. unit of dynamic viscosity. (5)
17. Periodic time of the earth's orbit about the sun which is used to define the civil calendar. (4)

Number Sequences

Suggested By: Sofiane Naci

1. 3, 8, 15, 24, 35...
 - 51
 - 48
 - 46
2. 6, 14, 18, 28, 30...
 - 32
 - 46
 - 42
3. $1/6$, $1/3$, $1/2$, $2/3$, $5/6$...
 - $5/3$
 - $4/5$
 - 1
4. 4, 1, 0, 1, 4...
 - 1
 - 3
 - 9
5. 2, 8, 26, 80, 242...
 - 728
 - 633
 - 260
6. 15, 210, 115, 220, 125...
 - 330
 - 200
 - 230
7. 2, 7, 4, 14, 6...
 - 10
 - 21
 - 8
8. -1, 4, 1, 6, 3...
 - 8
 - 10
 - 5
9. 1, 5, 13, 29, 61...
 - 97
 - 115
 - 125
10. 10, 21, 33, 46, 60...
 - 65
 - 75
 - 73

The Month's Trivia

Who Discovered What?

Suggested By: Sofiane Naci

1. This Scottish engineer developed the steam engine in the 1760s.
 - James Watt
 - William Ramsay
 - David Brewster
2. This US biologist whose research on the molecular structure of DNA and the genetic code earned him a shared Nobel prize in 1962.
 - Edwin Krebs
 - John Hughes
 - James Dewey Watson
3. This French chemist and micro-biologist discovered that fermentation is caused by micro-organisms and developed the germ theory of disease.
 - Louis Pasteur
 - Pascal Blaise
 - Jacques Charles
4. This psychiatrist studied myth, religion, dream symbolism, saw the unconscious as a source of insight, and distinguished between introversion and extroversion.
 - Karen Horney
 - Carl Gustav Jung
 - Sigmund Freud
5. He was a Greek physician often called the founder of medicine.
 - Pythagoras
 - Thales of Miletus
 - Hippocrates
6. Albert Einstein's theories of relativity revolutionized our understanding of matter, space, and time. This German physicist lived between...
 - 1879-1955
 - 1809-1885
 - 1905-1970

Sudoku

Suggested by: Mohamed Ali Teffahi

Fill in the grid so that every row, every column, and every 3x3 box contains the digits 1 through 9.

Rating: **Mild**

	1	7	6		4			8
	6	4						7
2			8					
6	8				1			
	3	9				2	5	
			7				8	6
					7			2
4						6	1	
1			5		6	8	7	

Solutions to these problems will appear in the next issue

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